United States Patent [19]

Ali et al.

[11] **3,797,413**

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[54] **INCINERATOR**

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[73] Assignee: **General Electric Company,** Indianapolis, Ind.

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[52] **U.S. Cl.** ..... **110/8 R,** 110/8 A, 110/72 R

[51] **Int. Cl.** **F23g 5/00**

[58] **Field of Search** ..... 110/8 R, 8 A, 18 R, 72 R

[56] **References Cited**

UNITED STATES PATENTS

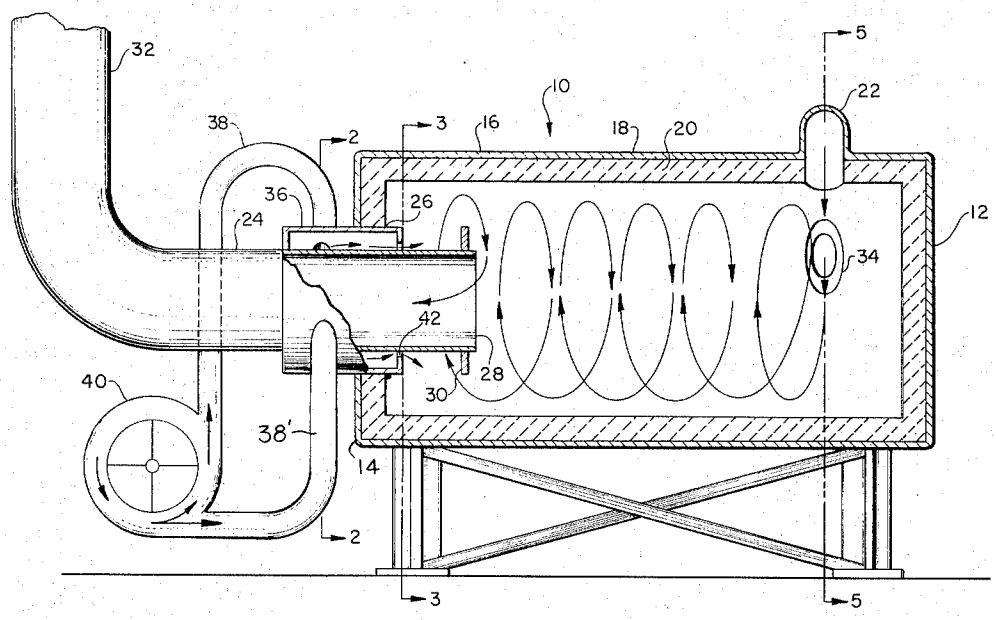
3,567,399	3/1971	Altmann et al.	110/8
3,577,940	5/1971	Hasselbring et al.	110/8
3,658,017	4/1972	Dibelius et al.	110/8
3,727,563	4/1973	Hasselbring et al.	110/8

Primary Examiner—Kenneth W. Sprague

[57] **ABSTRACT**

An incinerator for burning waste material having a combustion chamber comprising spaced end walls and a side wall through which a mixture of waste material and air is vortically moved and burned. The incinerator combustion chamber includes an exhaust flue port passing through one end wall to exhaust combustion gases, comprising a flue pipe extending substantially coaxially with the chambers longitudinal axis. The flue pipe is provided with a surrounding annular plenum chamber supplied with cooling gas which is discharged from the plenum chamber and flows over the surface of the section of the flue pipe within the combustion chamber.

10 Claims, 5 Drawing Figures



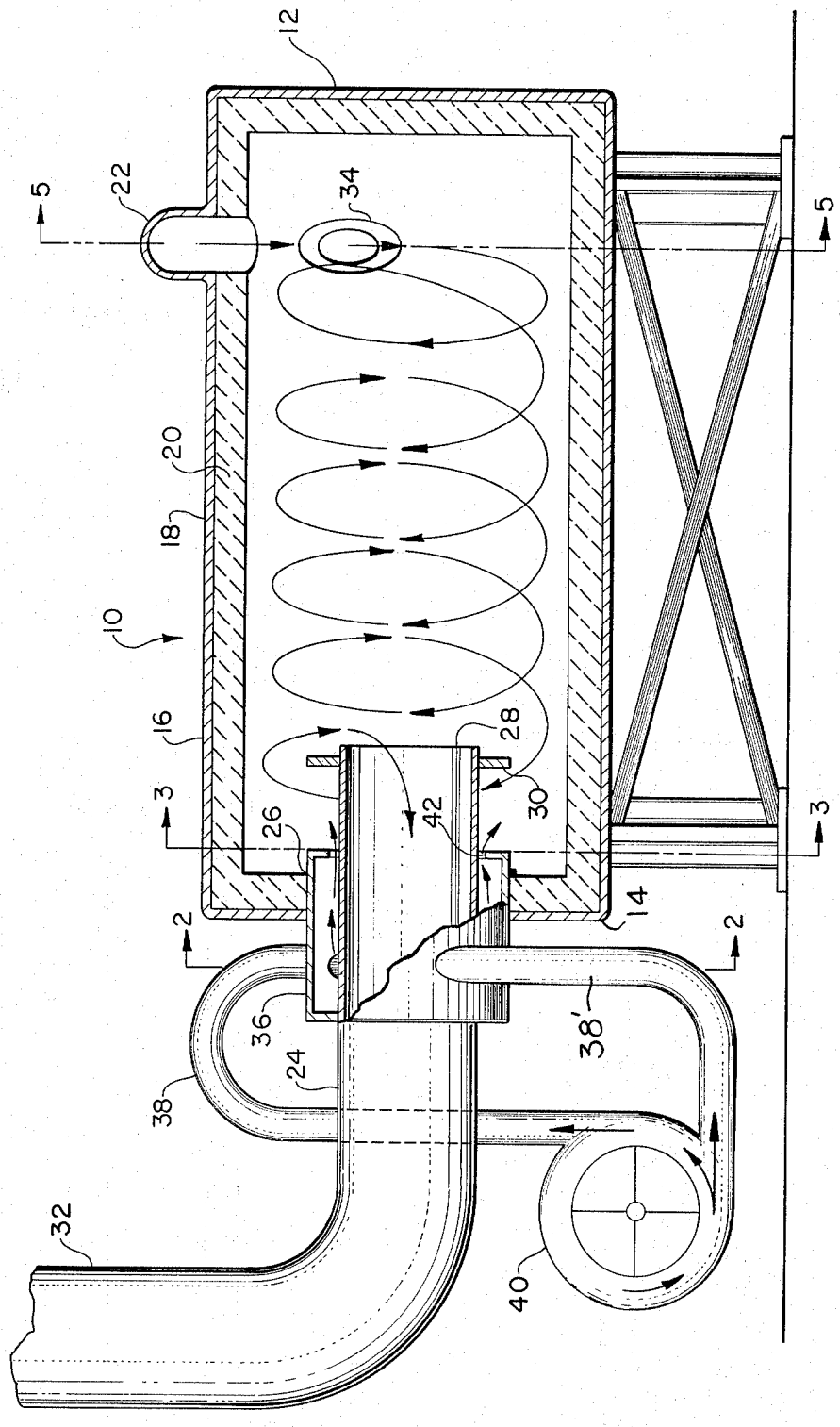


FIG. 1

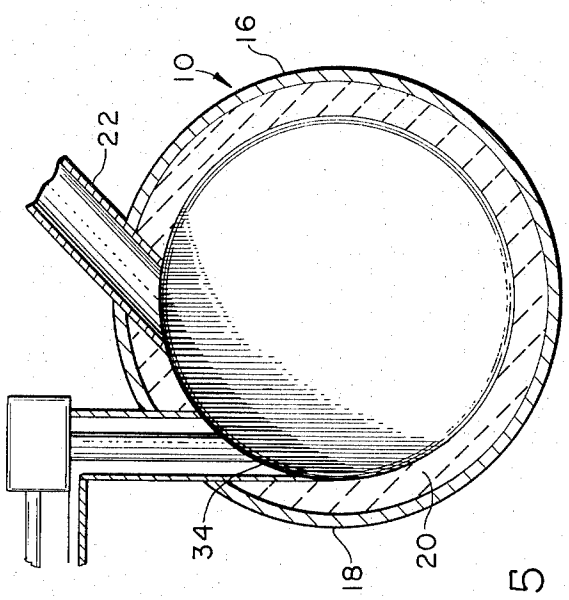


FIG. 5

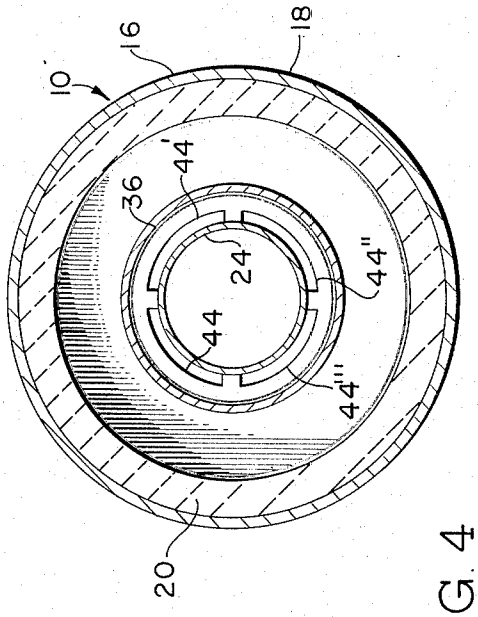


FIG. 4

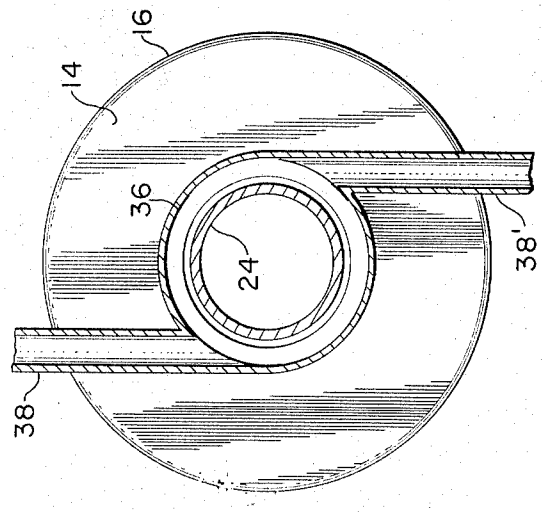


FIG. 2

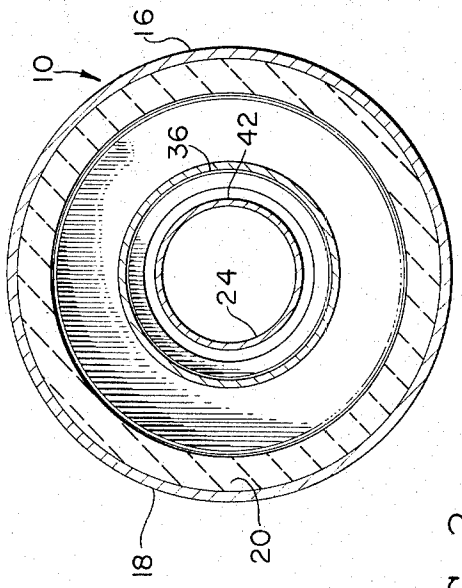


FIG. 3

INCINERATOR

CROSS REFERENCE TO RELATED APPLICATIONS

Certain features disclosed in this application are disclosed and claimed in U.S. Pat. No. 3,577,940, issued May 11, 1971 to Robert J. Hasselbring and Robert L. Shields, and U.S. Pat. No. 3,658,017, issued Apr. 25, 1972 to Norman R. Dibelius and William L. Zabriskie, assigned to the same assignee of the present invention.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to incinerators and has particular relation to municipal and industrial type incinerators for burning waste material.

2. Description of The Prior Art

To comply with regulatory air pollution codes, waste disposal incinerators such as the municipal and industrial type, frequently employ flue gas cleaning apparatus to minimize the discharge to the atmosphere of noxious gases or smoke and solid products of incomplete combustion rather than increase operating combustion temperatures to more efficient and complete incinerating levels because of the rapidly accelerated rates of apparatus deterioration and wear due to the higher temperatures of combustion and abrasion of increased velocities of the combustion gases. Flue gas cleaning apparatus are usually of costly and bulky construction and in some cases do not operate to clean the flue gases sufficiently to comply with regulatory codes. One type of flue gas cleaning apparatus includes means for conducting the gaseous product of combustion through water sprays so that the suspended ashes and other particulate matter are entrained in the water which is then collected and conveyed to a suitable classification system. This type of flue gas cleaning apparatus is expensive and complex and contributes not only to the high costs and massive structure of prior art incinerators, but also to water pollution. Further, the temperatures within the chamber necessary to effect good combustion may result in hot flue gases which may cause inefficient operation of the flue gas cleaning apparatus and resulting undesirable pollution of the surrounding atmosphere. The provision of flue gas cleaning apparatus thus imposes a limitation upon the temperature within the combustion chamber which contributes to the poor combustion realized by certain prior art designs.

OBJECTS OF THE INVENTION

It is therefore a primary object of this invention to provide a novel and improved incinerator capable of effecting substantially complete combustion of waste material at very high incinerating temperatures and having improved means for maintaining prolonged operation and apparatus service life which minimizes replacement of components and down time for repair.

It is another object of this invention to provide a novel and improved incinerator wherein cooling means is provided for the combustion gas exhausting flue pipe.

It is a further object of this invention to provide a novel and improved incinerator of the foregoing character wherein the cooling gas is applied in a particularly effective manner passing over and blanketing the surface of flue pipe for exhausting hot combustion gases to inhibit the deterioration of the flue pipe. It is also an object of this invention to provide an incinerator which enables the use of higher combustion temperatures to minimize air pollution without accelerating deterioration of the flue venting means due to the higher temperatures and abrasion of the combustion gases.

SUMMARY OF THE INVENTION

In carrying out the invention in one preferred form, an incinerator is provided which includes a combustion chamber having spaced end walls and a side wall with its central longitudinal axis extending between the end walls. The chamber is generally cylindrical in configuration and is preferably disposed in operative position with the central longitudinal axis extending horizontally or substantially horizontally. Inlet means are provided for introducing waste material and air for combustion into the combustion chamber for establishing a vortical movement of the waste material toward one of the end walls while being incinerated, and exhaust flue means are provided for expelling gaseous combustion products from the chamber. Means are provided for igniting the waste material during its vortical movement along the combustion chamber.

The exhaust flue means comprising a flue pipe passing through an end wall of the combustion chamber and extending into said combustion chamber, is provided with an annular plenum chamber surrounding an intermediate portion thereof which is supplied with cooling gas. The plenum chamber is provided with at least one cooling gas discharge orifice which is arranged to direct the flow of discharged cooling gas over the surface of the portion of the flue pipe exposed to the interior of the combustion chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of the incinerator system of this invention with a portion shown in elevation;

FIG. 2 is a view in section taken along the line 2—2 of FIG. 1 and looking in the direction of the arrows;

FIG. 3 is a view in section taken along the line 3—3 of FIG. 1 and looking in the direction of the arrows;

FIG. 4 is a view in section of a modified embodiment of FIG. 3 which is also taken along the line 3—3 of FIG. 1 and looking in the direction of the arrows; and

FIG. 5 is a view in section taken along the line 5—5 of FIG. 1 and looking in the direction of the arrows.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to the drawing, there is illustrated in FIG. 1 an incinerator unit embodying the present invention and comprising a generally cylindrical combustion chamber, inlet means for feeding waste material and air into the combustion chamber for establishing a vortical movement of the waste material as it moves through the combustion chamber towards the opposite end of the chamber and exhaust means at the opposite end of the chamber comprising a flue pipe for venting gaseous products of combustion. The incinerator also includes means for igniting the waste material during its vortical movement along the combustion chamber.

The incinerator of the present invention is particularly suited for disposing of solid industrial and munici-

pal waste material such as, for example, paper, peanut hulls, cardboard cartons, wood scraps, garbage, foilage, and combustible floor sweepings. However, the incinerator is also capable of disposing of liquid waste material such as oils, paint sludges, and plating tank residue.

Solids should preferably be reduced in size by chopping or shredding in a suitable size reduction unit to pieces small enough to be efficiently conveyed to and burned in the combustion chamber. If the waste material to be disposed of is already of an acceptable size, such as sawdust, the size reduction is not required.

The combustion chamber **10** of the incinerator unit may be of any suitable configuration and is preferably cylindrical including a pair of spaced end walls **12** and **14** connected by an annular side wall **16.** The chamber **10** is preferably disposed when in operative position so that its central longitudinal axis which extends between the end walls **12** and **14** is horizontal or substantially horizontal as shown in FIG. **1.** In the specific embodiment of the invention illustrated, the annular side wall **16** of the chamber comprises an outer casing **18** formed of a suitable material such as low carbon steel and the casing is lined with a refractory material **20** such as one or more layers of fire brick. The end walls **12** and **14** of chamber **10** may be similarly constructed of an outer casing **18** lined with a refractory material **20** such as fire brick.

In the embodiment illustrated, the waste material inlet conduit **22** enters the combustion chamber **10** tangentially of the annular side wall **16** at a location preferably near the top of the chamber **10** and adjacent the end wall **12.**

Continuous feeding of a mixture of waste material and air under pressure into the combustion chamber **10** from the inlet conduit **22** tangentially to the annular side wall **16** of the chamber establishes a vortical movement of the waste material and/or its combustion products which travels from adjacent the end wall **12** toward the end wall **14** in a clockwise, swirling direction as viewed from the end wall **12** in FIG. **1** during the incineration process. It is understood, of course, that the inlet conduit **22** may be disposed to enter the combustion chamber **10** tangentially in the opposite direction, in which event the direction of the vortex would be reversed from the clockwise, swirling direction to a counterclockwise swirling direction.

To exhaust gaseous products of combustion from the combustion chamber **10** to the atmosphere, a flue pipe **24** passes through a flue port **26** in chamber end wall **14** and extends into combustion chamber **10** substantially coaxially with the chamber's central longitudinal axis. The open end or entry **28** of the flue pipe **24** communicating with the interior of the combustion chamber for the withdrawal therefrom of gaseous combustion products is positioned inwardly a substantial distance away from the combustion chamber end wall, and an annular baffle **30** extends radially outward from adjacent its end. The opposite end of flue pipe **24** extends outwardly beyond the combustion chamber and communicates with a chimney or stack **32** to vent the gaseous products of combustion to the atmosphere.

With this arrangement any residual combustible material entrained in the stream of hot combustion gases flowing in a helical or vortical path along the inner surface of the chamber's side wall is not directly expelled through the flue upon approaching end wall **14.** Instead any entrained solid material tends to move from adjacent the end wall **14** in a reverse direction along the outer diameter of the inwardly extending flue pipe **24** towards its open end **28.** Such movement increases the time of residence of solid material in the chamber **10** thus resulting in more complete combustion and a reduction in the amount of this material which may enter the flue pipe and escape to the atmosphere as compared to the amount otherwise entering the flue pipe **24** if its open end **28** were flush with the end wall **14.**

Annular baffle **30** extending radially outward from adjacent the inner end of flue pipe **24** further reduces the amount of solid material entering flue pipe **24** by diverting any such solids outwardly toward the annular side wall of the combustion chamber and thus into the moving stream of combustion gases for further burning.

To ignite the waste material entering the combustion chamber **10,** a fluid fueled combustion burner **34,** such as one operated with gas or oil fuel, powdered coal or simply hot gases, is disposed near end wall **12** of the chamber, preferably directed to fire its flame jet into the combustion chamber tangentially to its annular side wall **16** and into the path of the waste material and air entering into the chamber through inlet conduit **22.** The combustion burner may be of any suitable design and comprise commercially available units, such as a MAXON burner, for example, an EB-3, EB-4, or EB-5, depending upon the size and capacity desired.

Under normal operating conditions wherein a mixture of shredded waste material and primary air is continuously fed into the combustion chamber, but dependent somewhat upon the moisture content and nature of the waste material to be incinerated, the burner can be turned off after heating the combustion chamber to effective ignition and burning temperatures whereupon the waste material and air thereafter sustain combustion. Apt operating temperature for the combustion chamber comprise about 1,200° F to about 2,200° F. Thus, a typical operating procedure will be to initially fire the burner alone for a period sufficient to preheat the combustion chamber up to its intended operating temperature whereupon the feeding of the size reduced waste material and air under pressure into the combustion chamber is initiated and combustion thereof incited by the thus attained high temperatures within the combustion chamber. Thereafter combustion may be self-sustaining without the need for added impetus provided by a separate source of fuel, but again depending upon the heat content and nature of the waste material "fuel" and its moisture content. However, if or when needed to maintain or regain effective combustion conditions because of the nature of the waste material, or for whatever reason, the burner can simply be continuously fired to maintain combustion, or reactivated to return the incinerator to effective combustion temperatures or conditions. In some cases, such as burning sewerage sludge which normally contains a relatively high moisture content, it may be feasible or even necessary to continuously fire the burner to maintain effective combustion conditions. Automatic means such as a temperature sensor within the combustion chamber can be provided to govern the firing of the ignition burner in response to the chamber temperature.

In accordance with this invention, an annular plenum chamber **36** surrounds a portion of the flue pipe **24** in

an area intermediate its length, for the circulation of a cooling fluid. Plenum chamber **36**, which may be constructed integral with the flue pipe **24**, preferably extends at least the length of the section of the flue pipe which passes through combustion chamber wall **14**, thereby straddling the chamber wall. Plenum chamber **36** may also continue longitudinally along the section of the flue pipe extending from the chamber wall **14** to the stack **32**, if desired, or if its length and the flue temperature conditions warrant. However, the plenum chamber **36** should be terminated back away from the open end **28** of the section of the flue pipe **24** projecting into the combustion chamber, and preferably at or adjacent to the inner surface of combustion chamber end wall **14**, substantially as shown in FIG. **1**.

Annular plenum chamber **36** is provided with at least one supply conduit **38** communicating with a source of cooling gas such as fan **40**, or any available source of recycled air which is of suitable temperature. Preferably the cooling gas supply conduit(s) **38** enter the annular plenum chamber **36** in a tangential direction to effect a swirling movement of the cooling gas in a helical path around the outer surface of flue pipe **24**, thereby achieving maximum uniform cooling over the adjacent surface of the flue pipe. An optimum arrangement comprises a plurality of cooling gas supply pipes **38,38'** symetrically arranged and tengentially entering annular plenum chamber **36** such as shown in FIG. **2**.

The annular plenum chamber **36** is also provided with at least one outlet orifice **42** in its enclosing structure facing the interior of the combustion chamber and adjacent to the outer surface of the portion of the flue pipe **24** extending beyond said surrounding plenum chamber into the combustion chamber. Preferably the orifice is annular, comprising a slot extending completely around flue pipe **24** such as shown in FIG. **3**. However the orifice **42** may comprise a multiplicity of openings such as ports **44, 44', 44''** and **44'''** arranged in an annular pattern such as shown in FIG. **4**. In either case the orifice, or orifices extending around the flue pipe, provide for the discharge from the plenum chamber of the cooling gas so as to flow over the outer surface of the portion of the flue pipe extending into the combustion chamber from the surrounding plenum chamber. Moreover, by inducing the preferred swirling pattern of movement in the cooling gas, it can be caused to thus exit from the orifice in the plenum chamber and sweep helically around the outer surface of the exposed inwardly extending portion of the flue pipe **24** cooling its mass and providing a blanketing barrier of cooling gas protecting its entire surface from the high temperatures of the furnace environment and impingement of circulating combustion gases and entrained solids.

The improved incineration construction of this invention as described prevents overheating of the flue pipe and its accelerated deterioration due to overheating and abrasion. Thus, the invention permits operating the incinerator at higher and often more efficient temperature levels without incurring damage or premature wear to the apparatus, and also extends the service life of the incinerator with a minimum of down time for repairs or replacement.

By means of this invention, a very efficient incinerator is provided characterized by the exhaust of gases to the atmosphere which are substantially free of particulate matter so as to minimize air and water pollution resulting from the substantially complete combustion of all combustible waste material at the most efficient high temperature conditions.

Although the invention has been described with reference to certain specific embodiments thereof, numerous modifications are possible and it is desired to cover all modifications falling within the spirit and scope of the invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. An incinerator for burning waste material, comprising in combination:

a. a combustion chamber having spaced end walls and a side wall with its central longitudinal axis extending between said end walls;

b. inlet means for introducing waste material and air into said chamber in a manner effective for providing a vortical movement of said waste material towards one of said end walls;

c. means for igniting said waste material during its vortical movement;

d. an exhaust flue port passing through one end wall of the combustion chamber substantially concentric with said central longitudinal axis, comprising a flue pipe extending into said combustion chamber having an open end positioned inward away from the one end wall; and,

e. an annular plenum chamber surrounding a portion of the flue pipe in an area intermediate its length and having at least one supply conduit communicating with a source of cooling gas entering into said plenum chamber, said annular plenum chamber being provided with at least one orifice adjacent to the surface of the flue pipe extending therefrom into the combustion chamber whereby cooling gas can discharge from the plenum chamber through said orifice and flow over the surface of the flue pipe.

2. The incinerator of claim **1**, wherein the supply conduit for cooling gas enters into the annular plenum chamber in a tangential direction to cause a swirling movement of the cooling gas around the surface of the flue pipe.

3. The incinerator of claim **2**, wherein the orifice in the plenum chamber for the discharge of cooling gas is an annular slot extending around the flue pipe.

4. The incinerator of claim **2**, wherein the orifice in the plenum chamber for the discharge of cooling gas is a plurality of openings positioned in an annular arrangement around the flue pipe.

5. The incinerator of claim **1**, wherein the annular plenum chamber surrounds at least the portion of the flue pipe which passes through the combustion chamber end wall.

6. The incinerator of claim **5**, wherein the annular plenum chamber surrounding an intermediate area of the flue pipe which passes through the combustion chamber end wall, terminates within the combustion chamber approximately adjacent the inner surface of the end wall of said chamber.

7. The incinerator of claim **6**, wherein the orifice in the annular plenum chamber directs the discharged cooling gas along the surface of the flue pipe extending therefrom into the interior of the combustion chamber.

8. The incinerator of claim 7, wherein the annular plenum chamber is provided with at least two cooling gas supply conduits entering said chamber in tangential directions to cause a swirling movement of the cooling gas around the surface of the flue pipe.

9. An incinerator for burning waste material, comprising in combination:

a. a combustion chamber having spaced end walls and a side wall with its central longitudinal axis extending between said end walls;

b. inlet mans for introducing waste material and air into said chamber in a manner effective for providing a vortical movement of said waste material towards one of said end walls;

c. means for igniting said waste material during its vortical movement;

d. an exhaust flue port passing through one end wall of the combustion chamber substantially coaxially with said central longitudinal axis, comprising a flue pipe extending a predetermined distance into said combustion chamber and having an open end for communication with the interior of the combustion chamber positioned inward away from the one end wall; and,

e. an annular plenum chamber surrounding a length of the flue pipe in the area passing through the one end wall of the combustion chamber and having at least one supply conduit communicating with a source of cooling gas entering into said annular plenum chamber in a tangential direction to cause a swirling movement of the cooling gas around the surface of the flue pipe, said annular plenum chamber being provided with at least one orifice adjacent to the surface of the flue pipe extending therefrom into the combustion chamber and being directed to discharge cooling gas from said plenum chamber to flow over the surface of the flue pipe extending therefrom into the interior of the combustion chamber in a swirling path.

10. The incinerator of claim 9, wherein the annular plenum chamber surrounding a length of the flue pipe extends from outside the combustion chamber and through the end wall of the combustion chamber and terminates within the combustion chamber approximately adjacent to the inner surface of the end wall of said chamber.

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